Simulation Tools

for

Evaluating the Operational Performance

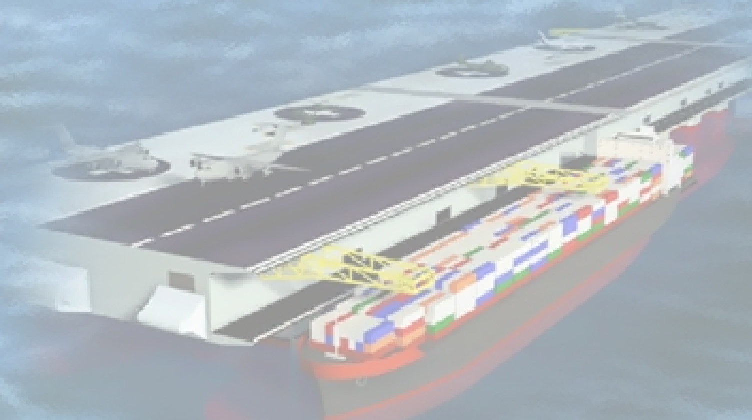
of the

Mobile Offshore Base

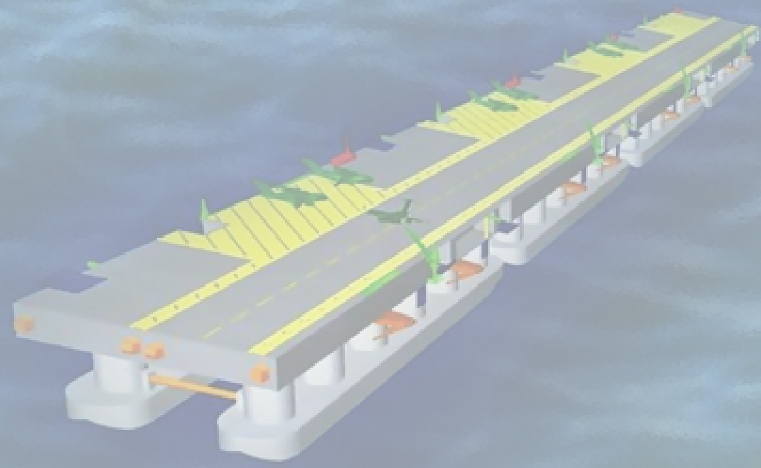
Ronald Brackett & Michele Murdoch

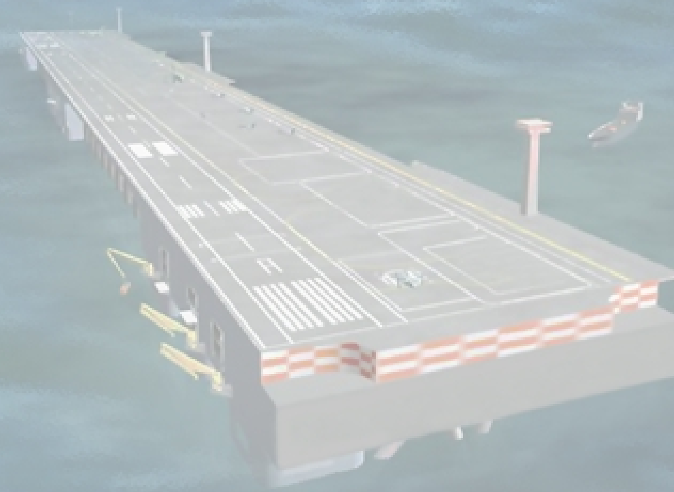
Naval Logistics Conference

15 November 2000



What is a M.O.B.?

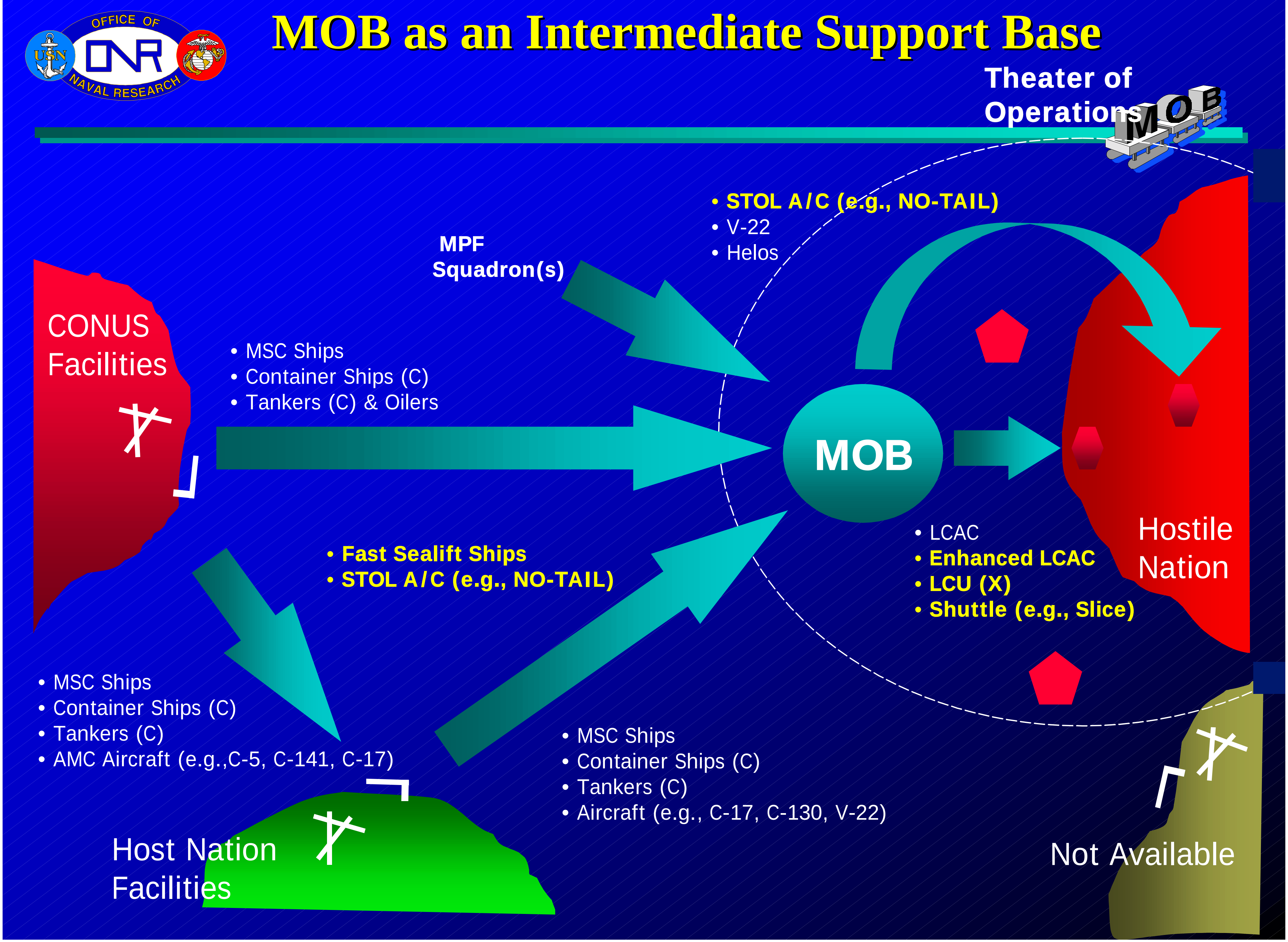




MOB General Functions

- A multi-functional, reconfigurable, floating platform for U.S. and Allied Forces that provides operational and sustainment basing support for:
  - » *Naval Operations*
  - »*Flight Operations*
  - » *Personnel*
  - » *Equipment Storage*
  - » *Supply & Maintenance*
  - » *Military Operations Other Than War*

MOB as an Intermediate Support Base



Major Mission Specific Capabilities

MOB

Logistics (CVBG)

- Daily Cargo Through-put in support per CVBG
  - Provision/Store
    - 24 Metric Tons
  - DFM
    - 580,000 Liters
  - JP5
    - 1 Million Liters
  - Ordnance
    - 150 Metric Tons

SOF

- Up to 10,000 SOF personnel
- 74 Rotary/Fixed-wing aircraft, 22 combatant craft

Water
  - 6 Million Liters
- Fuel & Dry Cargo for SOF equipment
  - 40.5 Million Liters
  - 9,700 Metric Tons Cargo

OMFTS

- Up to 20,000 MAGTF personnel
- 128 Rotary/Fixed-wing aircraft, 62 lighterage
- Strategic Sealift and Airlift (C-17 capable)
- Water
  - 24 Million Liters
- Fuel & Dry Cargo for MAGTF equipment
  - 67.5 Million Liters
  - 16,200 Metric Tons Cargo

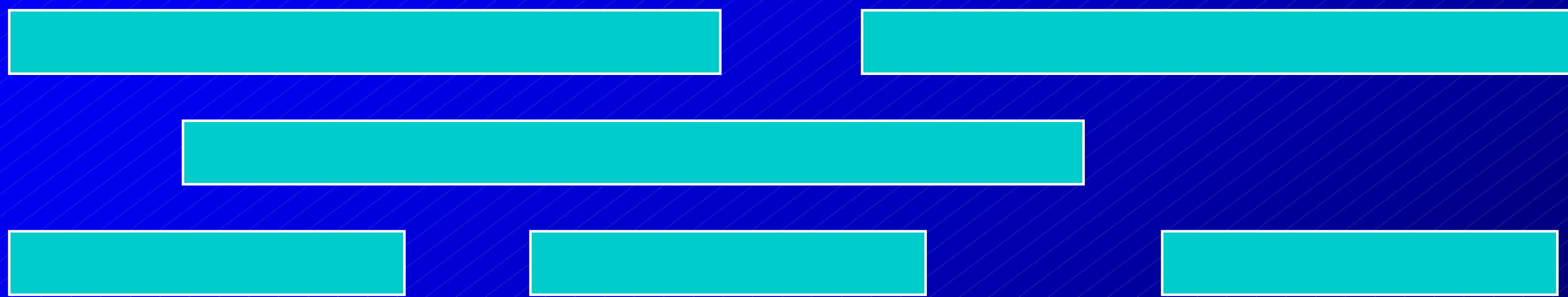
EXAMPLE

Why Simulation?

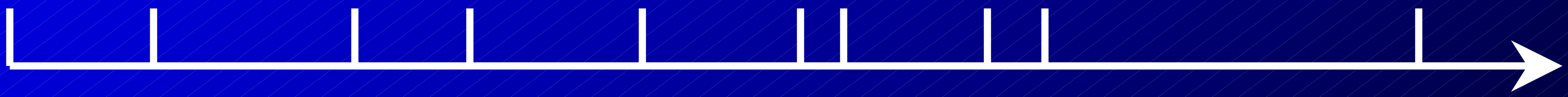
- MOB Concepts are unprecedented in size and scope of operational requirements.
- No experience base
- Differences in proposed concepts:
  - Size & mass
  - Response to environmental loads
  - Storage volume
- Allows an objective and consistent comparison of concepts and systems.

Types of Simulation Models

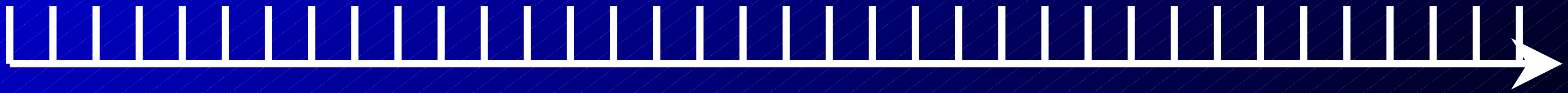
Systems or Processes



- Discrete Event



- Continuous Time



MOB Simulation Models

Models	Types	Software
Constructability	Discrete Event	Extend
Air Cargo Transfer Rate	Discrete Event	Extend
Ship Cargo Transfer Rate	Discrete Event	Arena
Operational Availability	Continuous Time	Extend

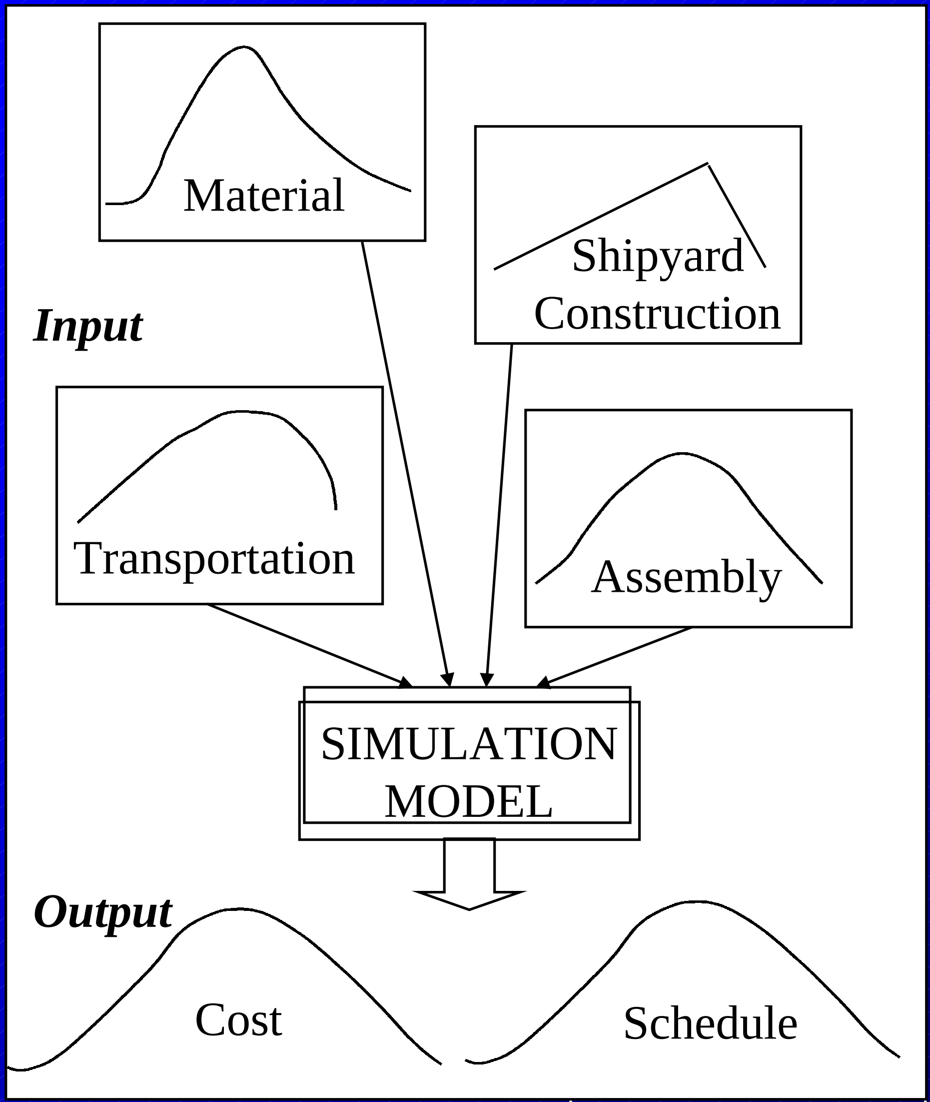
MOB Constructability Models

Mob Constructability Models

- **Purpose of Models:**
  - Could the Structure be Built?
  - Over What Time Period?
  - At What Cost?
  - With What Risks?

- **Common Features:**
  - Discrete-Event, Based in Extend
  - 2 Scenarios Modeled for Each of 5 Concepts
  - Assumes Multiple Shipyards Contribute

MOB Constructability Models



After Ayyub et al, July 1999

Simulations Address:

- Availability of Raw Materials
- No. of Shipyards Involved
- Availability of qualified workers
- Time Required for Each Step

Models Incorporate:

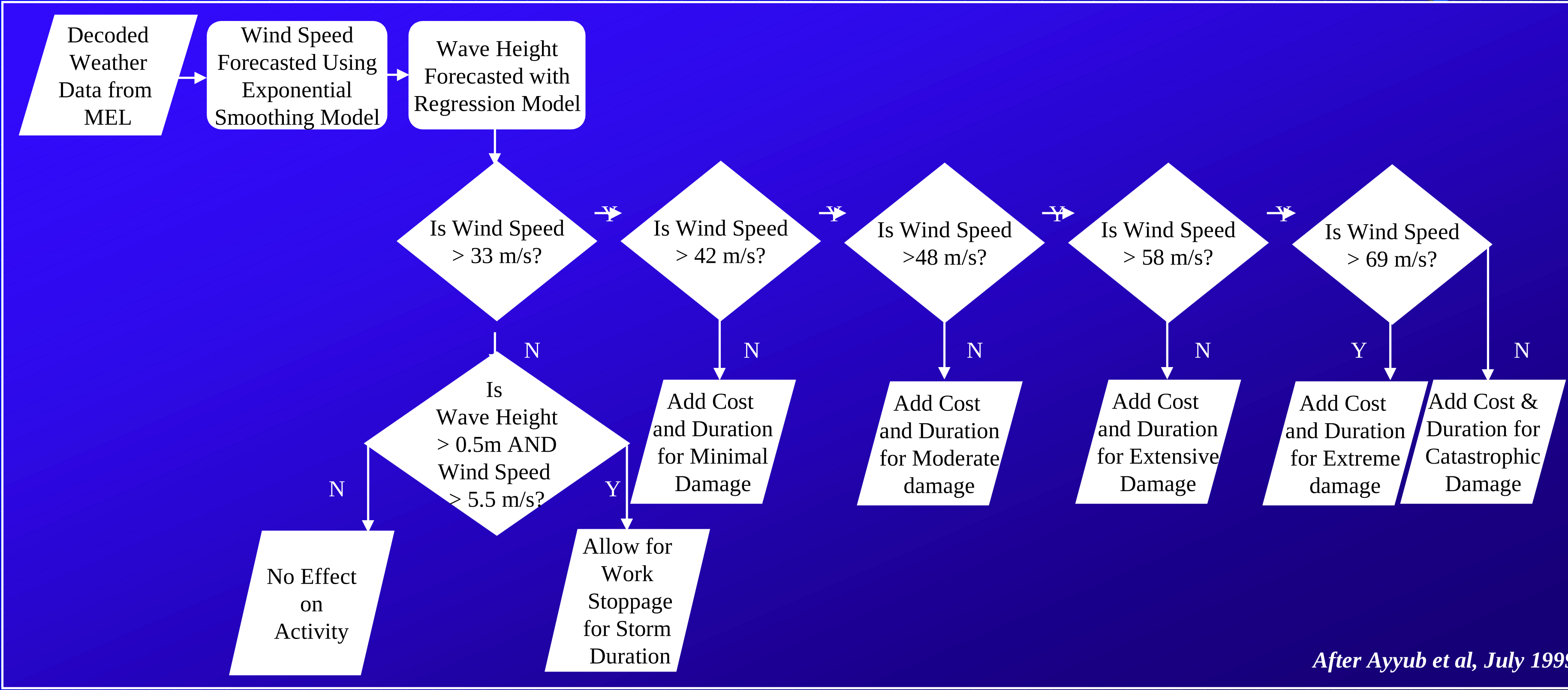
- Statistical Distributions to Simulate Availability of Parameters
- Fuzzy Logic Sets to Address Impact of Construction Management Issues

MOB Constructability Models – Results

RESULTS:

- MOB Construction is Feasible Using Projected Capabilities of U.S. Shipbuilding and Construction Industry
- Costs and schedule results ranged from $300M to $1500M and 3 to 5 years per module, depending on concept & module length.
- Models can be used to evaluate alternative construction scenarios and conduct sensitivity studies.

MOB Constructability Models – Weather Impacts



After Ayyub et al, July 1999

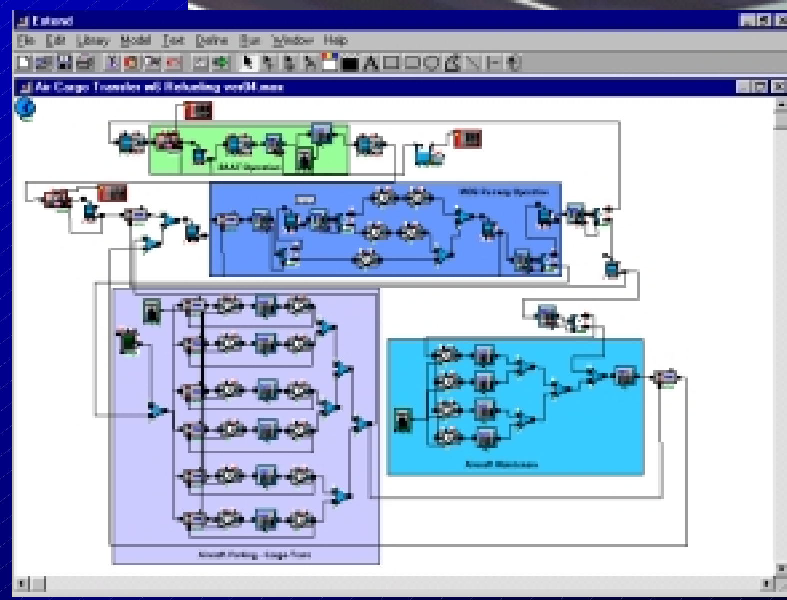
Results from Initial Simulations Showed:

- 23% increase in schedule
- 5% increase in cost (no hurricanes in data sample)

Air Cargo Transfer Rate Model

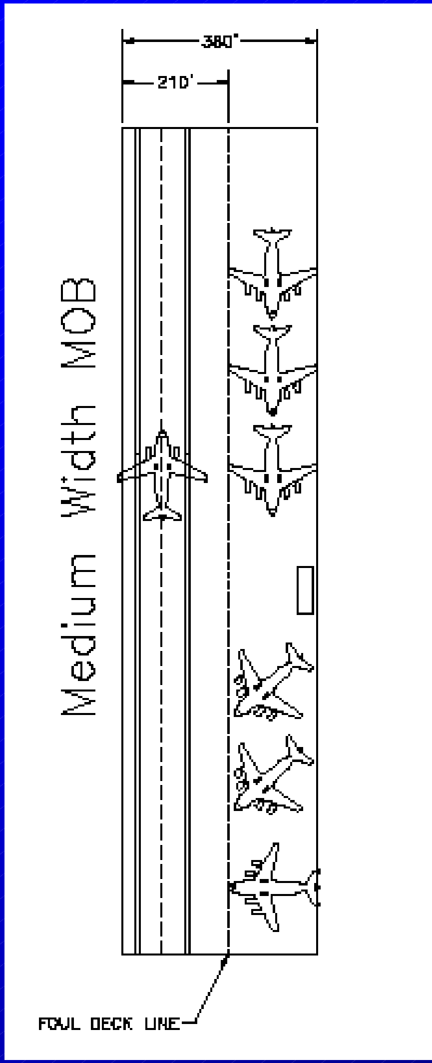
Air Cargo Transfer Rate Model

- Objective
  - Develop a model that will provide an assessment of aircraft and air cargo flow onboard a MOB
  - Conduct a parametric analysis to determine the effect of various MOB configuration options on air cargo transfer rates.

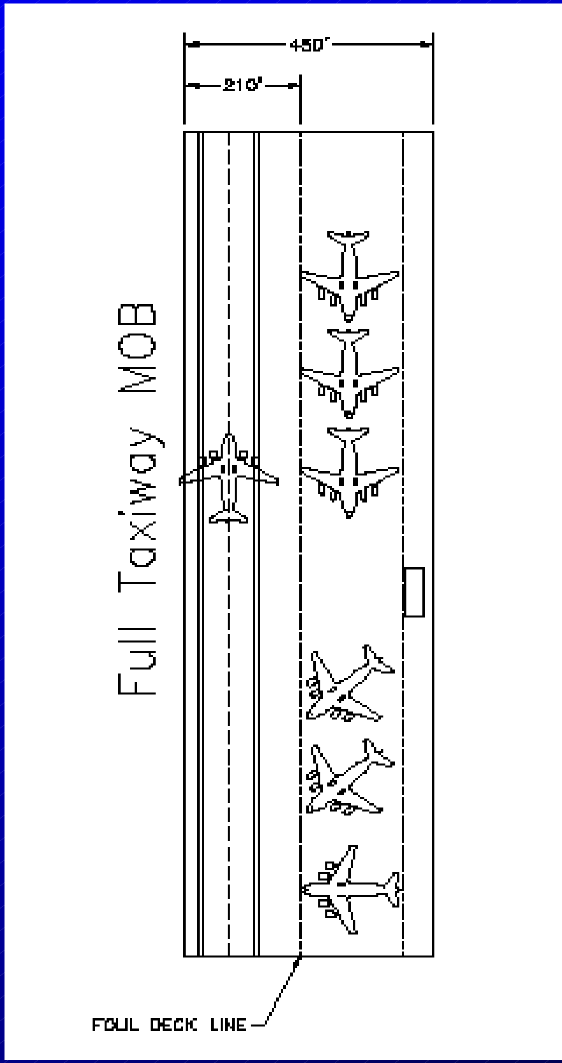


MOB Runway Configuration Options

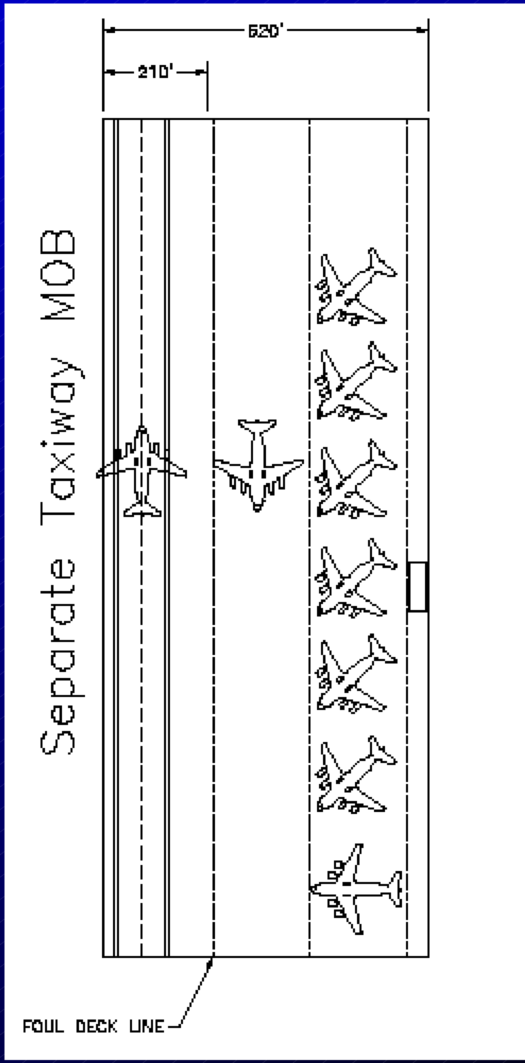
380 ft flight deck



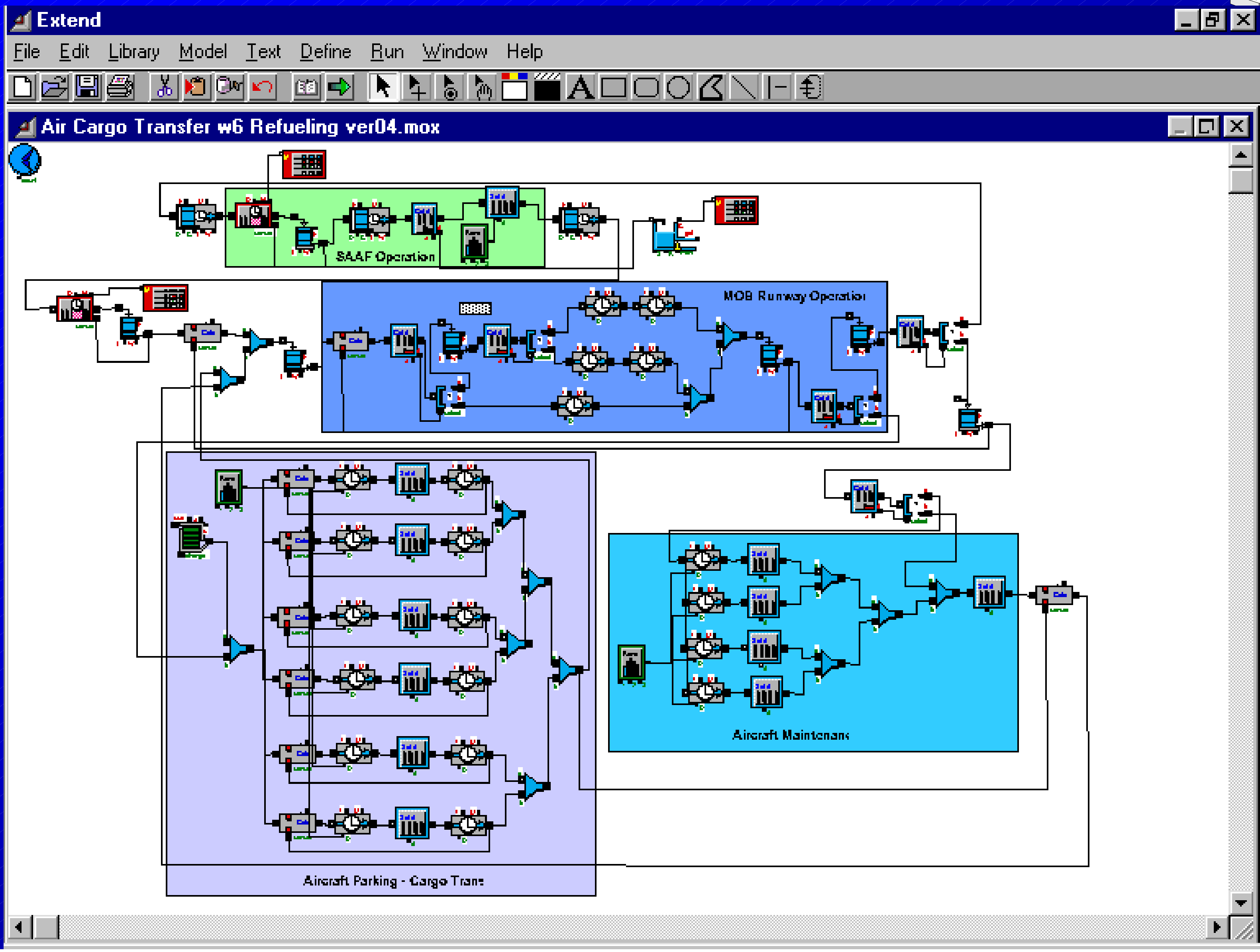
450 ft flight deck



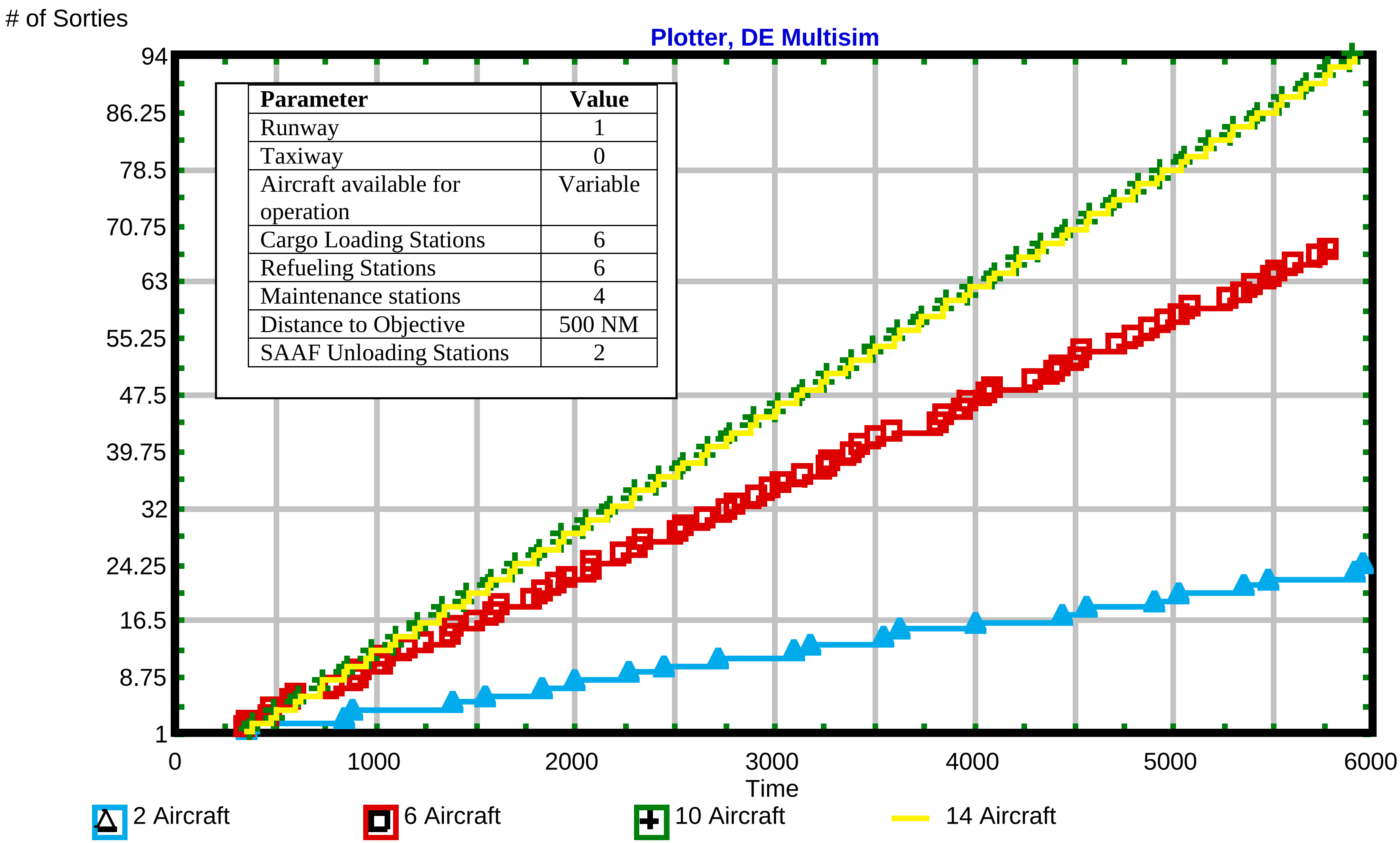
520 ft flight deck



Air Cargo Transfer Rate Model

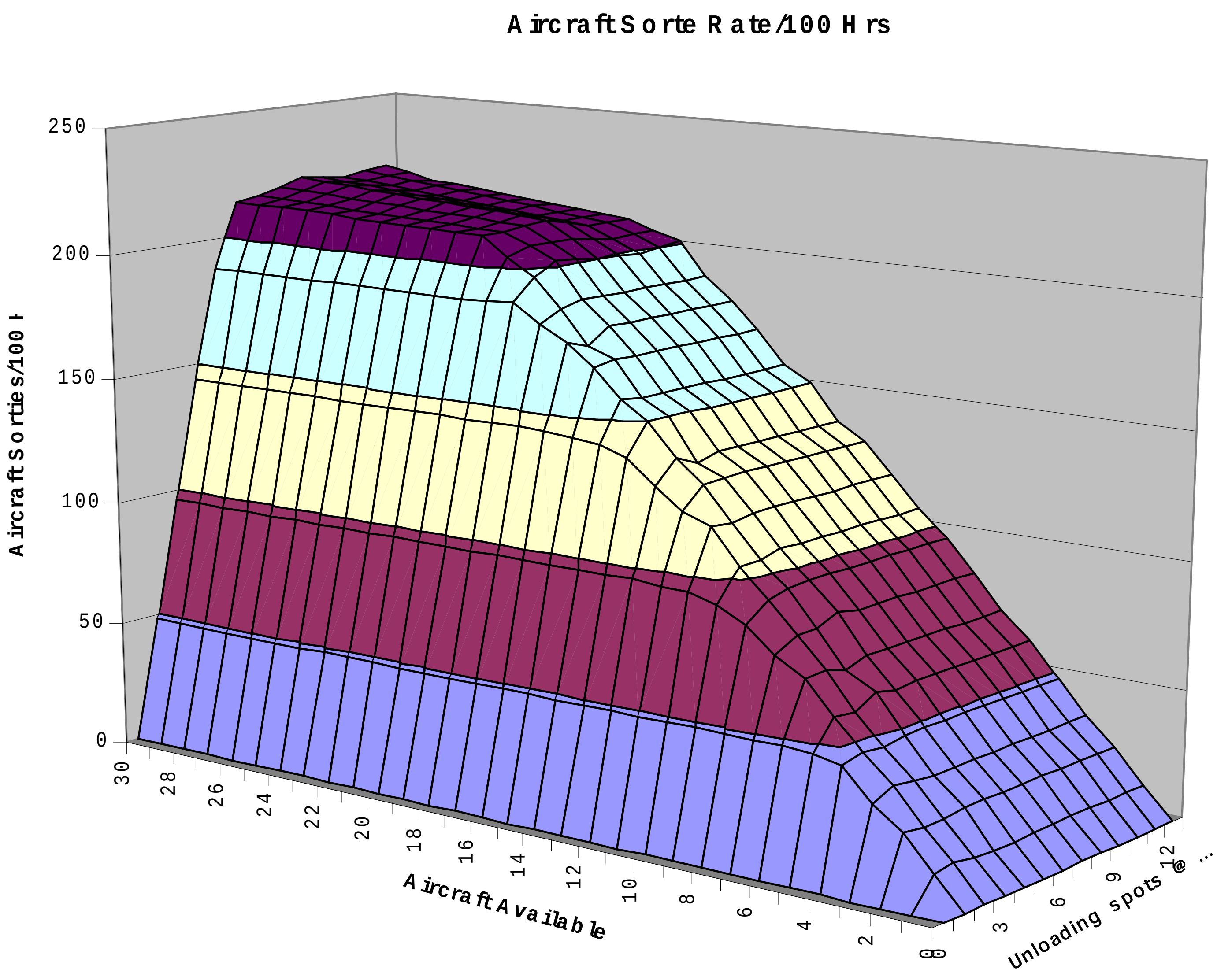


Aircraft Sorties vs Number of Aircraft Available



Parameter	Value
Runway	1
Taxiway	0
Aircraft available for operation	Variable
Cargo Loading Stations	6
Refueling Stations	6
Maintenance stations	4
Distance to Objective	500 NM
SAAF Unloading Stations	2

Parametric Air Operations Analysis



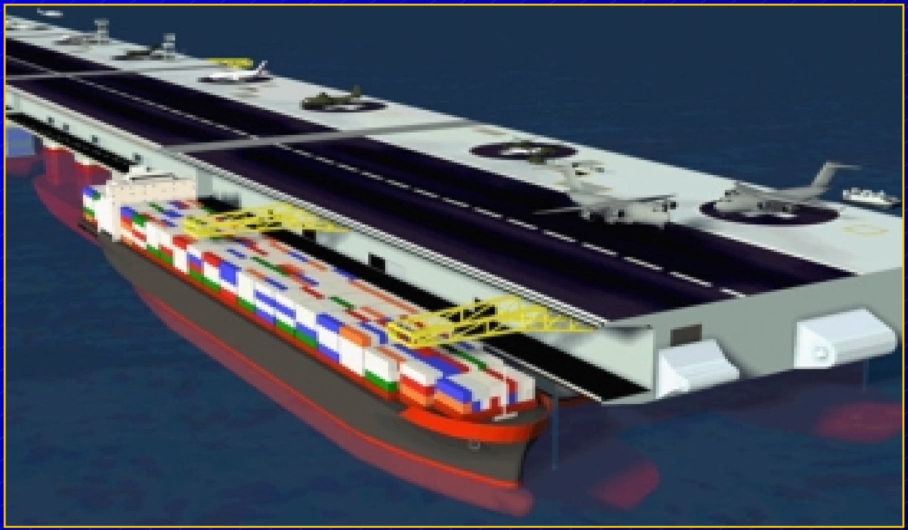
Air Cargo Transfer Rate - Results

- Adding a separate Taxiway does not improve Transfer Rate unless:
  - # of available aircraft > 30
  - # of MOB aircraft loading spots > 12
  - # of SAAF aircraft unloading spots > 12
- With a single Runway/Taxiway – Runway utilization becomes saturated at 3 outbound flights/hr.
  - » Utilization: Take off = 34%, Landing = 36%, Taxi = 25%
- A separate Taxiway increases sortie rate by 33%, but runway still becomes saturated at just over 4 outbound flights/hr.
  - » Utilization: Take off = 45%, Landing = 48%

Ship Cargo Transfer Rate Model

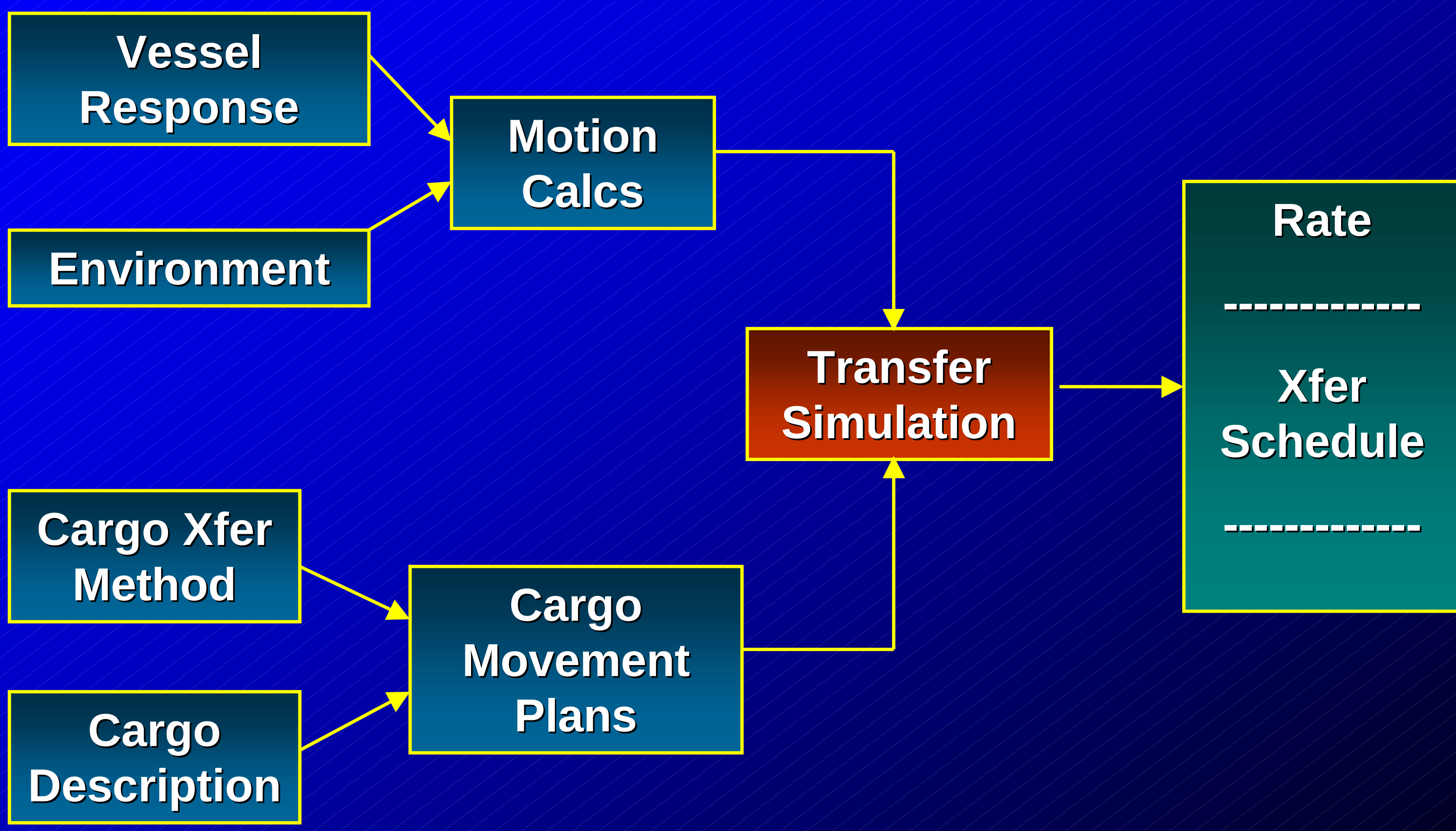
Ship Cargo Transfer Rate Model

- **Create an analytically robust method to estimate cargo transfer rate between MOB and auxiliary vessels under variety of environmental conditions**



- Status
  - Preliminary Model and Interem Report delivered - March 99
  - Ship Motion analysis completed - Aug 99
  - Final Model and Report due March 00

Overall Modeling Strategy

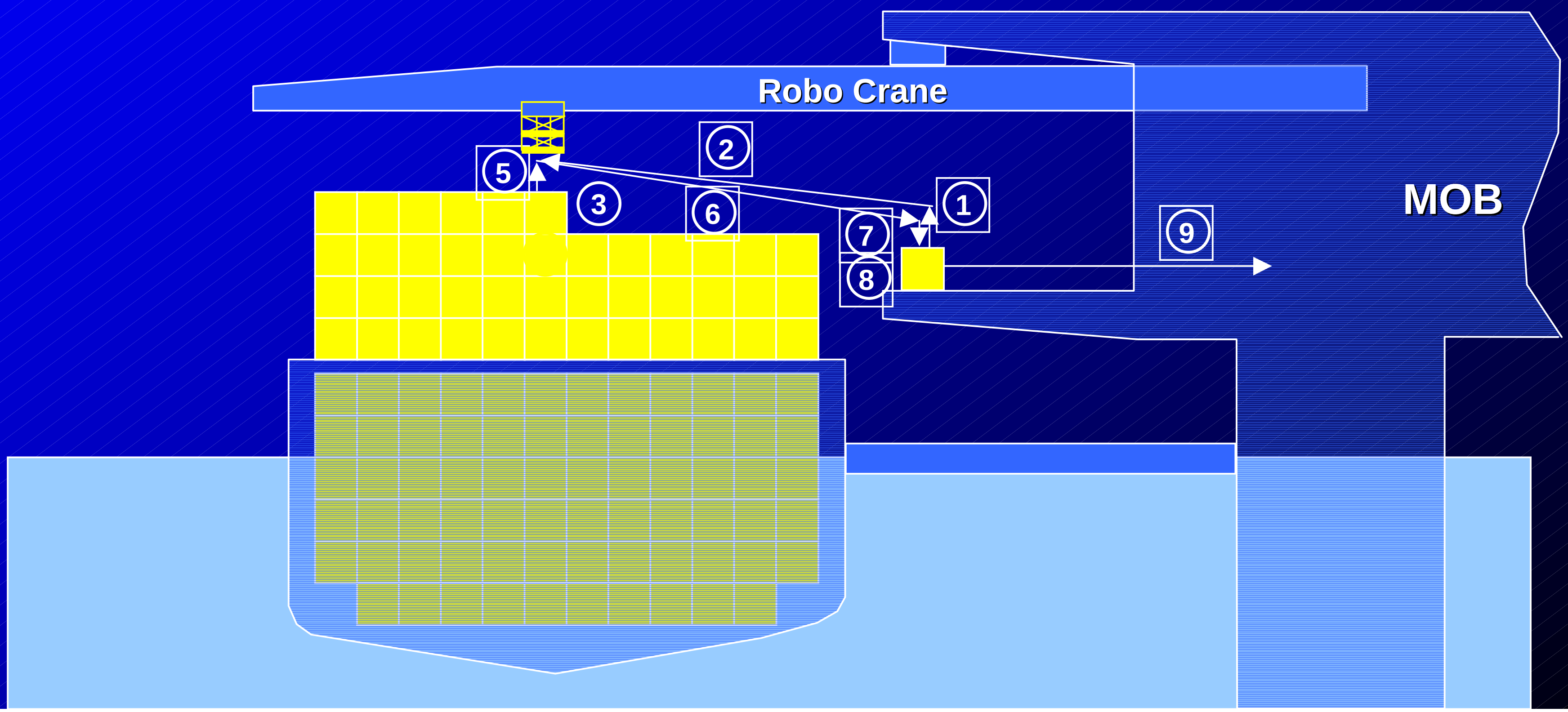


Container Movement Steps

<u>Movement Steps</u>

1. Lift to travel position
2. Move to target
3. Focus on target*
   Insert in Cell Guide*
   Lower in Cell Guide*
4. Latch
   Lift in Cell Guide*
5. Lift to travel position
6. Move to unload
7. Drop to unload
8. Unlatch
9. Store on MOB

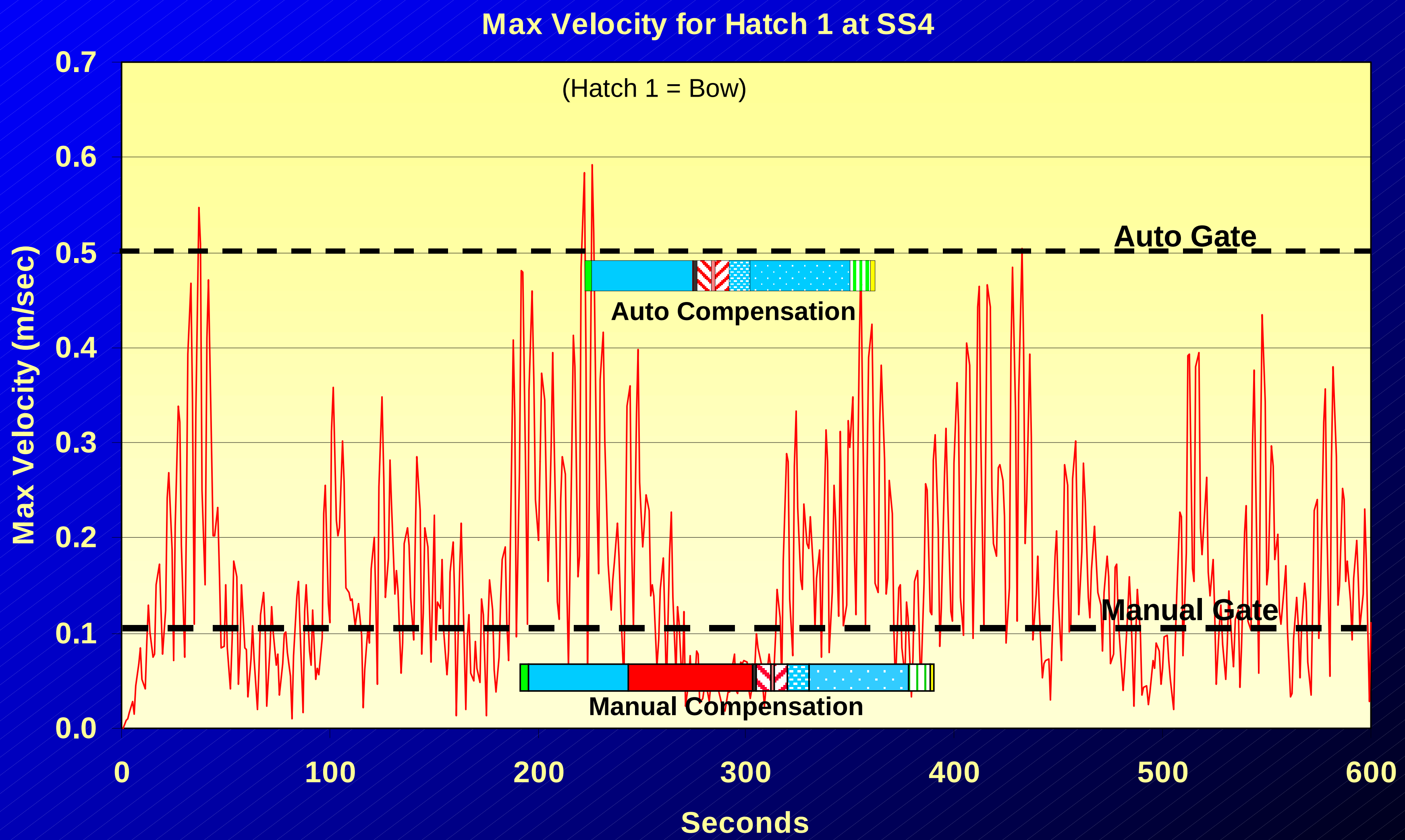
(*Gated operation)



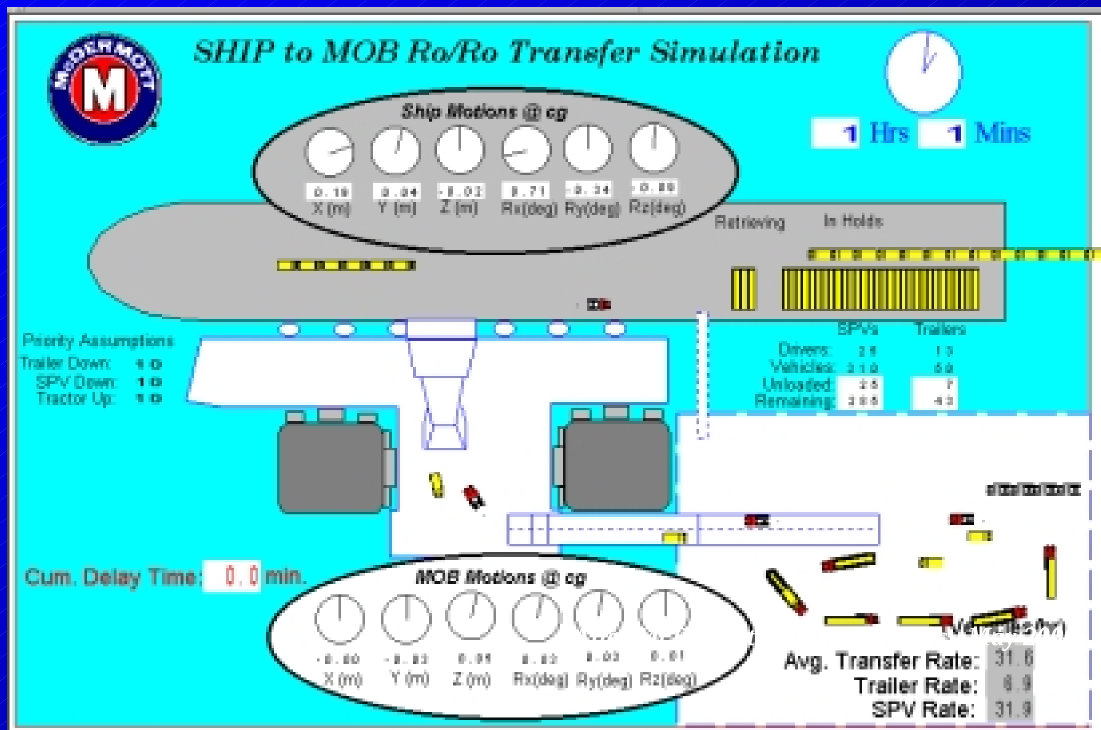
Cargo Transfer Rate Model Conclusions

- Simulation works as tool for determining transfer rate
- Preliminary results
  - Expect about 29 containers / hr as maximum transfer rate on MOB
  - Motion compensated crane design is likely choice for MOB, with manual backup capability
  - Capability of crane designs to acquire target should be focus of crane-testing programs
- Model needs to be calibrated from field test data

Applied to Motion Data



RO/RO Cargo Transfer Models

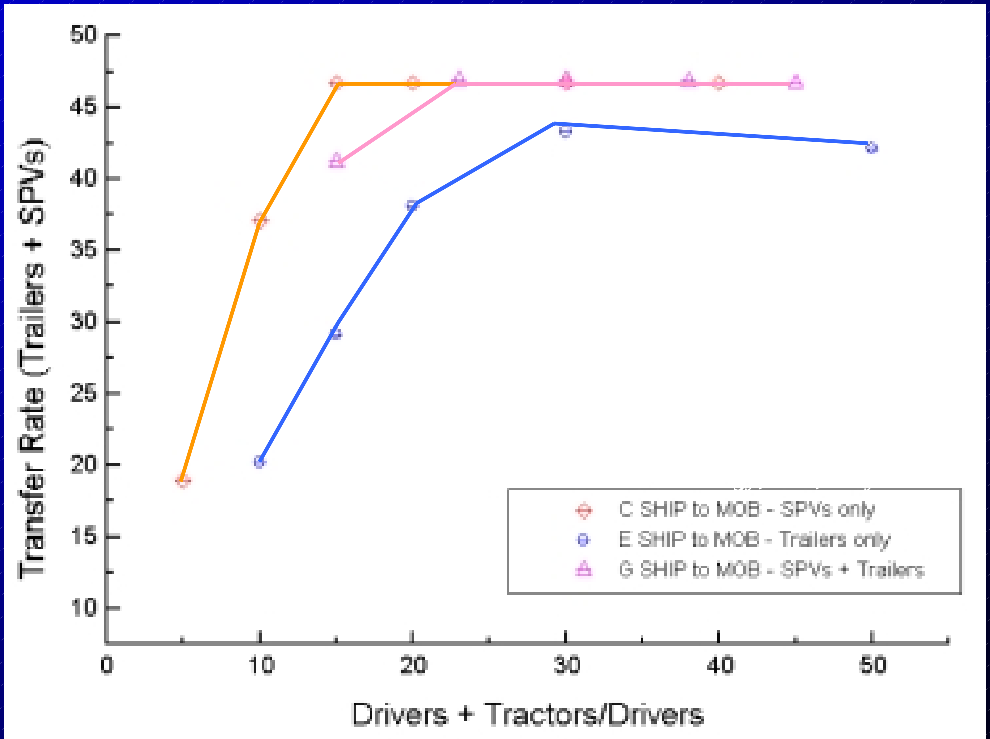


- Motion Gates for Ramp Angle and Vessel Pitch
- Simulates Transfer of Both Self-Propelled and Tractor-Pulled Vehicles
- Separate Models for Transfer to and from Cargo Vessels

RO/RO Cargo Transfer Models

Applications:

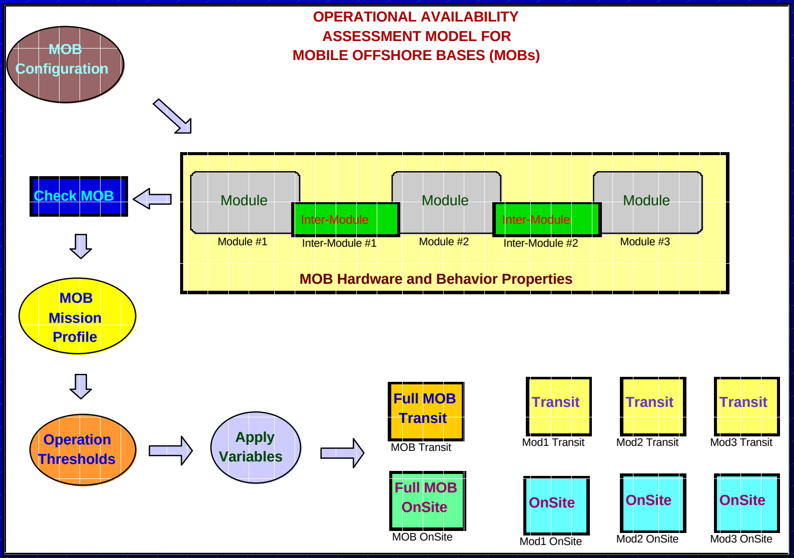
- Estimating Rolling Cargo Transfer Rate Between Vessels and MOB at Different Seastates and Headings
- Evaluate Different Equipment and Operating Parameters
  - ➢Ramp Length
  - ➢Number of Drivers
  - ➢Distance to Storage Locations, etc.
- Input to Ao Model

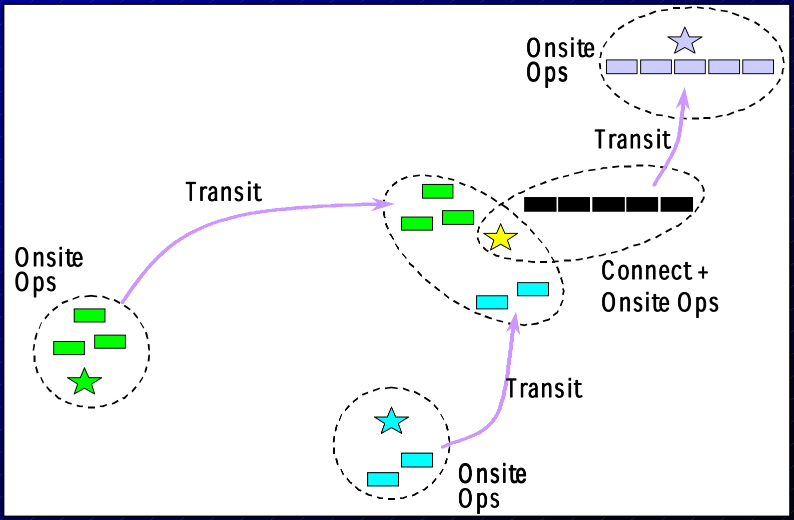


Operational Availability (Ao) Model

Operational Availability Model

- Assess the performance of any MOB concept relative to the Mission Needs Statement
- Investigate the sensitivity of various performance parameters to changes in Concept Configuration and Mission Requirements





What is Ao?

"Failed" "Repaired" "Failed"

Logistics Delay Time | Repair Time | Available Time | → Time

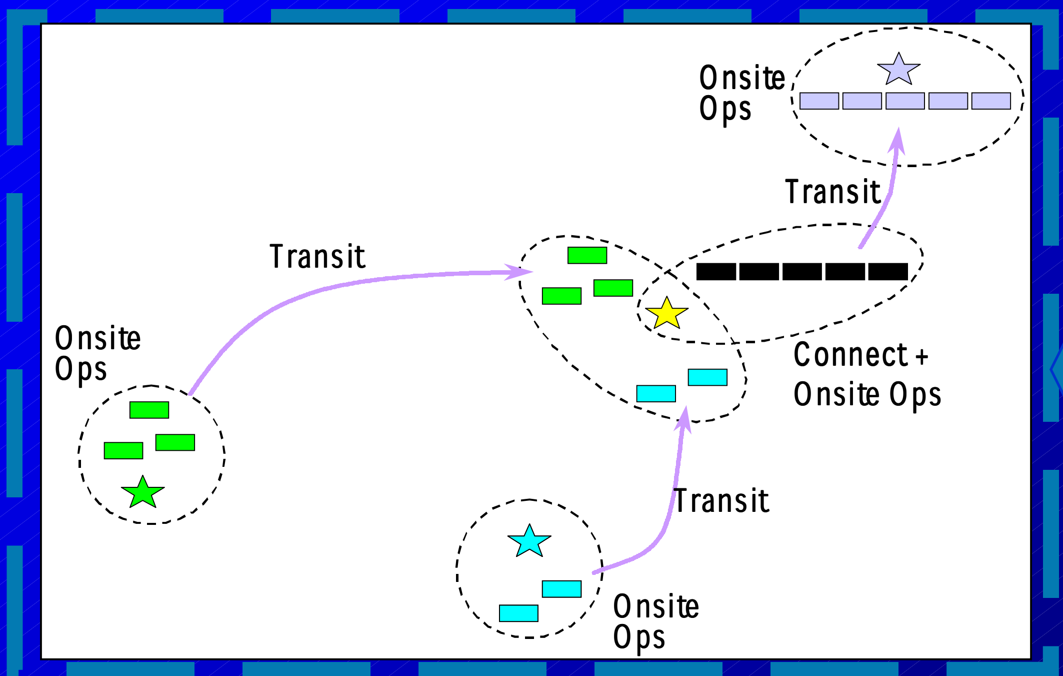
$$Ao = \frac{\text{Available Time}}{\text{Total Time}}$$

Reliability → Available Time

Maintainability → Repair Time

Supportability → Logistics Delay Time

Mission Scenario Diagram

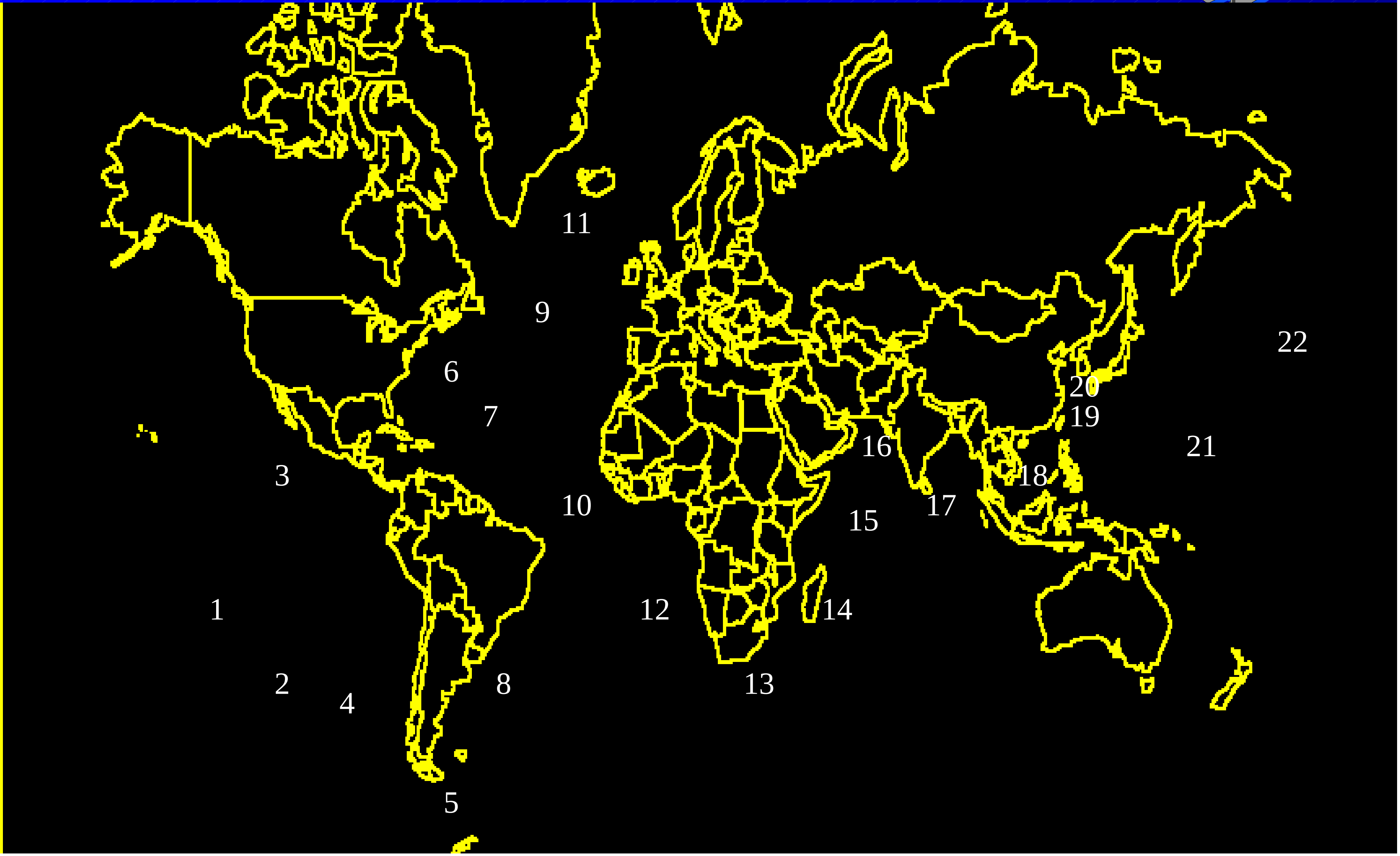


Wind/wave/current Databases

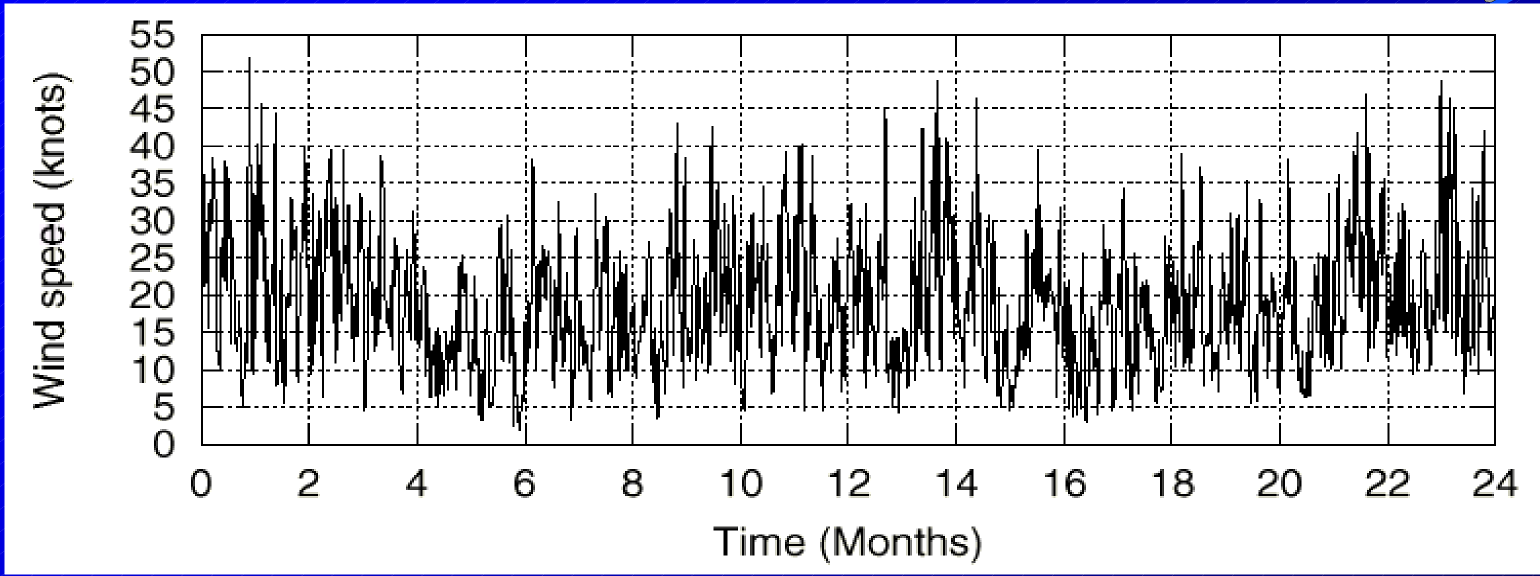
Large-scale
Typhoon scale

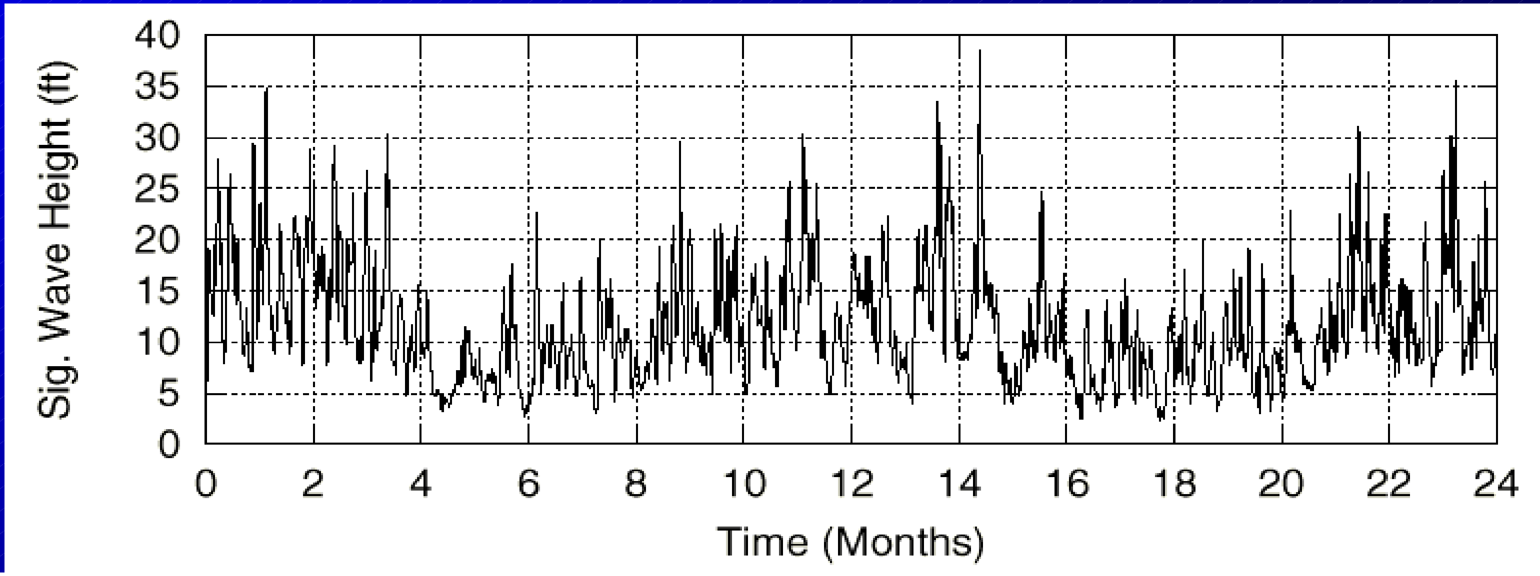
- Quantify performance versus
  - Platform configuration,
  - Metocean characteristics of various sites,
  - Mission Requirements

Met/Ocean Database Sites

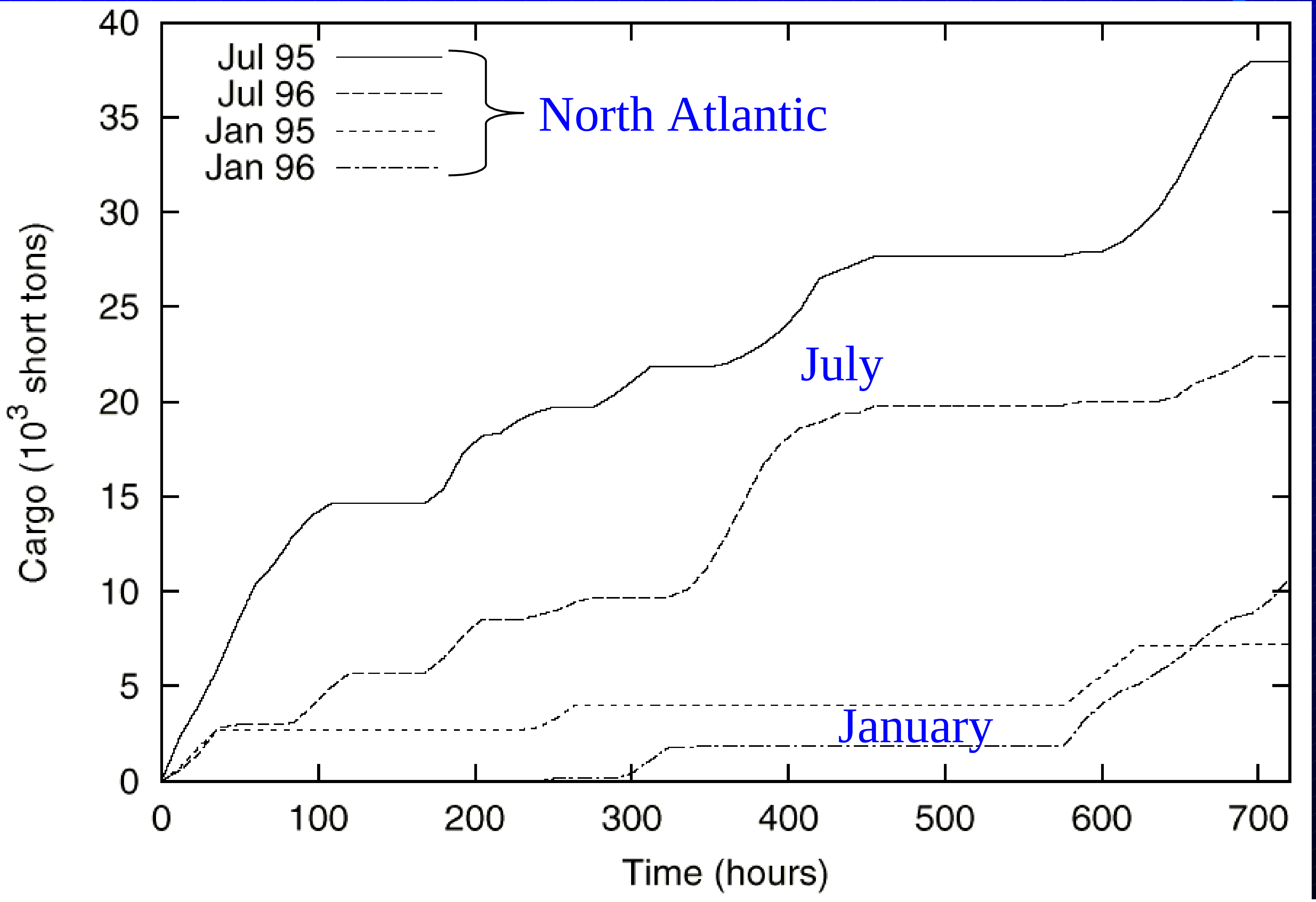


Environmental Conditions – North Atlantic Site





Sea Cargo Transfer vs. Month



Ao Statistics - Site Comparison

Site	Capability	Ao	MTBF	MTTR
North Atlantic	Air Ops	0.9662	343.1	12.0
	Sea Ops	0.5131	73.2	70.0
	Stationkpg	0.9986	1086.0	1.5
Western Pacific	Air Ops	0.9903	957.3	9.4
	Sea Ops	0.8676	296.0	45.2
	Stationkpg	0.9975	1239.8	3.1
Arabian Sea	Air Ops	0.9993	1580.7	1.1
	Sea Ops	0.9048	715.6	75.3
	Stationkpg	0.9993	1580.7	1.1
Sea of Japan	Air Ops	0.9966	912.7	3.1
	Sea Ops	0.9476	402.1	22.2
	Stationkpg	0.9987	1086.7	1.4

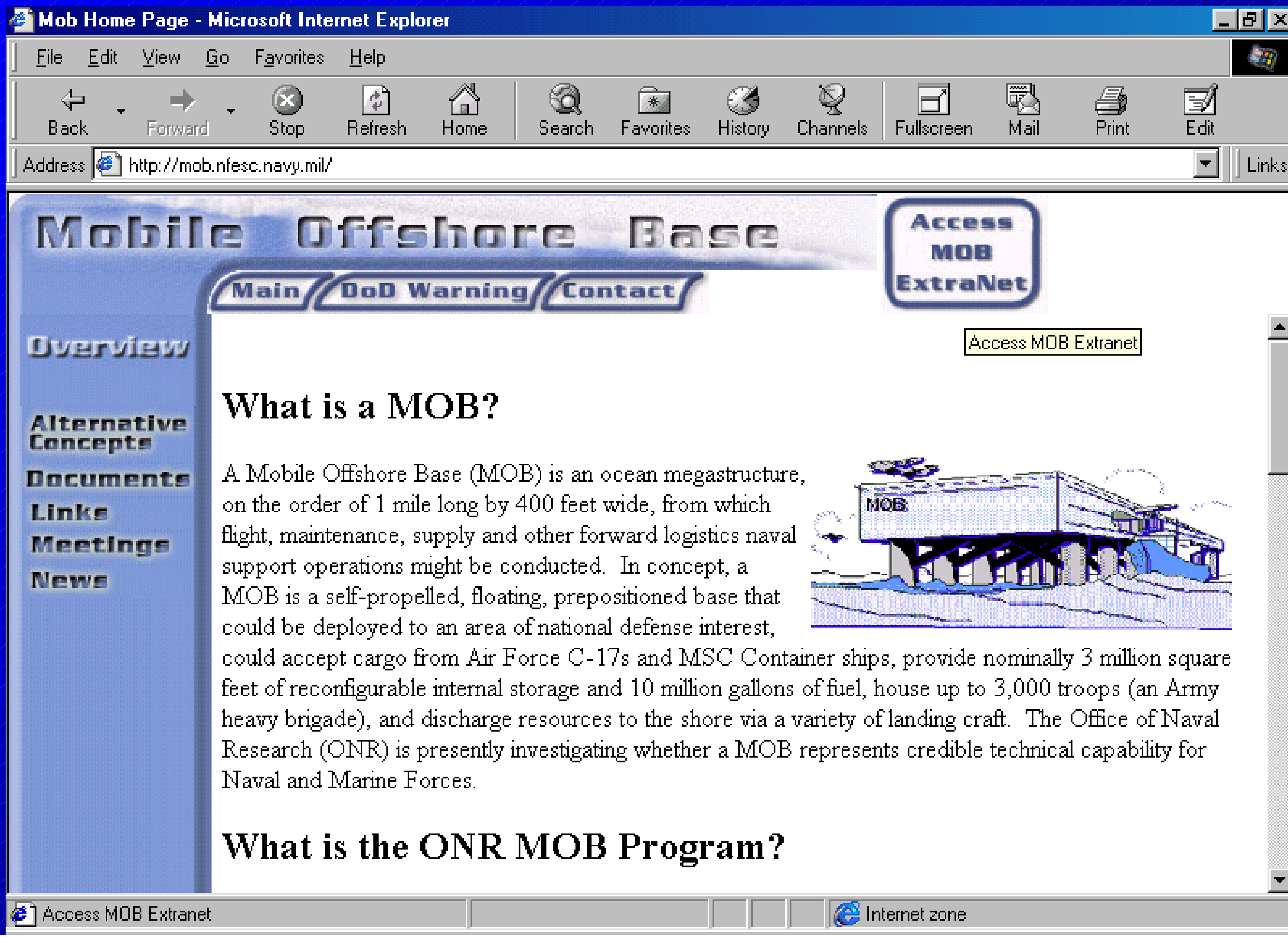
(Hours)

Why Simulation Modeling? - Revisited

- Creating models early in the program forces ***definition of system interfaces*** and guides the management team to asks a lot of important questions.
- Model input requirements ***identify data shortfalls***
- Early reliability allocations are possible to *guide program*, identify technology shortfalls, etc.
- The Ao Model provides a ***structure for integrating data*** from many different development efforts.
- If causes of down time can be predicted, cost-effective backup systems can be identified and factored into the design before expensive ship-alts are required.

For More Information

- Visit the MOB WEB Site: **http://mob.nfesc.navy.mil**



Mob Home Page - Microsoft Internet Explorer

File Edit View Go Favorites Help

Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit

Address http://mob.nfesc.navy.mil/ Links

Mobile Offshore Base

Main DoD Warning Contact

Access MOB ExtraNet

Overview

Alternative Concepts
Documents
Links
Meetings
News

Access MOB Extranet

What is a MOB?

A Mobile Offshore Base (MOB) is an ocean megastructure, on the order of 1 mile long by 400 feet wide, from which flight, maintenance, supply and other forward logistics naval support operations might be conducted. In concept, a MOB is a self-propelled, floating, prepositioned base that could be deployed to an area of national defense interest, could accept cargo from Air Force C-17s and MSC Container ships, provide nominally 3 million square feet of reconfigurable internal storage and 10 million gallons of fuel, house up to 3,000 troops (an Army heavy brigade), and discharge resources to the shore via a variety of landing craft. The Office of Naval Research (ONR) is presently investigating whether a MOB represents credible technical capability for Naval and Marine Forces.

What is the ONR MOB Program?

Access MOB Extranet Internet zone